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SID 63-143-6

ACTUAL WEIGHT AND BALANCE REPORT

BOILERPLATE NO. 6

C/M AND L.E.S. FOR PAD ABORT

CONTRACT NAS 9-150

(U)

ISSUED 21 JUNE 1963

PREPARED BY

WEIGHT CONTROL GROUP

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

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ACTUAL WEIGHT AND BALANCE REPORT

FOR

BOILERPLATE NO. 6

C/M AND LES FOR PAD ABORT

INTRODUCTION

An actual weight and balance determination of the Launch Escape System and Command Module for Boilerplate No. 6 was conducted by the Apollo Weight Control Group at the Space and Information Systems Division of North American Aviation, Inc. The weights and centers of gravity for the Command Module and Launch Escape motors and tower, were obtained by methods of weighing each assembly in two planes. A breakdown of the actual weighings conducted, along with the centers of gravity derived from each weighing, is listed below. All weighings were witnessed by a NASA Representative.

ASSEMBLY	CENTER OF GRAVITY
L.E.S. Less tower	X and Y
L.E.S. Less tower	X and Z
L.E.S. Tower	X and Y
L.E.S. Tower	X and Z
C/M (horizontal)	X
C/M (vertical)	Y and Z
L.E.S. and C/M (vertical-combined)	Y and Z

The enclosed data represent the actual weight and center of gravity of the Launch Escape System and Command Module. Calculated values for the moments of inertia are also included.

Changes due to structural rework, ballast adjustments, shortages and replacement of systems or parts since the actual weighings, are incorporated and summarized on the actual weight and balance data forms as total corrections. These corrections are provided in detail on page 14 for the L.E.S. and page 15 for the C/M. For convenience, the summary for the L.E.S., page 9 , account for the total corrections made to the complete assembly.

Corrections for a difference in gravitational forces between the geographical location of the weighing system initial calibration and the location at Downey, Calif. are accounted for. The Δ "g" corrections are based on the International Standard.

A final ballast adjustment was not necessary for the Launch Escape System after the actual weight and balance determinations. The specified longitudinal center of gravity (Xa 1109.0) for the combined Command Module and Launch Escape

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System at Launch Escape burnout was met within tolerance. The rocket, jettison, and pitch control motors were inert at the time of the weighing, and it probably will be necessary, however, to make ballast adjustments to the L.E.S. upon weighing the live motors at White Sands Missile Range.

A ballast adjustment was required to the Command Module after the actual weight and balance to correct to the target weight and center of gravity. This resulted in the removal of 257.8 pounds of ballast and relocation of an additional 257.8 pounds of ballast. The ballast determination assumed that the weight for the dummy parachute, on board at the time of the weighing, was the same as the production article.

The information shown on the actual weight and balance data form, page 13, for the combined weighing of the Command Module and the Launch Escape System, reflect the actual weight and center of gravity of the stacked assemblies after Thrust Vector Alignment was performed.

An actual weight and balance determination for Boilerplate No. 6 Command Module and Launch Escape System will be conducted at White Sands Missile Range prior to launch. The information derived from these weighings will be incorporated as an appendix to this report.

WEIGHT, CENTER OF GRAVITY AND INERTIA SUMMARY

PAD ABORT

INITIAL AND BURNOUT

BOILERPLATE NO. 6

ITEM	WEIGHT	CENTER OF GRAVITY*			MOMENTS OF INERTIA (SLUG-FT.^{2})		
		X	Y	Z	ROLL (X)	PITCH (Y)	YAW (Z)
Launch Escape System** Command Module	6430 9008	1296.9 1042.0	-0.7 1.0	0.1 7.3	213 5025	8356 4277	8350 4229
ABORT - INITIAL	15438	1148.2	0.3	4.3	5283	65294	65202
LESS: Escape Motor Prop. LESS: Pitch Motor Prop.	-3194 - 17	1295.8 1429.0	0.0 0.0	0.0 0.0	69 ---	1265 ---	1265 ---
AT L.E.S. BURNOUT	12227	1109.2	0.4	5.4	5197	44700	44624

NOTES: *Centers of gravity are in the NASA reference system except that the longitudinal has an origin 998.7 inches below the tangency of the Command Module structure mold line.

**Since the L.E.S. motor assembly was angularly adjusted to align the thrust vector with respect to the gross center of gravity, the Launch Escape System was corrected to meet the actual center of gravity of the initial abort configuration.

WEIGHT, CENTER OF GRAVITY AND INERTIA SUMMARY

PAD ABORT

(C/M AT IMPACT)

BOILERPLATE NO. 6

ITEM	WEIGHT	CENTER OF GRAVITY*			MOMENTS OF INERTIA (SLUG-FT^2)		
		X	Y	Z	ROLL (X)	PITCH (Y)	YAW (Z)
COMMAND MODULE	9008	1042.0	1.0	7.3	5025	4277	4229
LESS: Forward Cover	-394	1100.2	-0.1	2.8	76	51	47
LESS: Drogue Chute	- 28	1091.0	9.8	-22.1	-	-	-
C/M PRIOR TO MAIN CHUTE DEPLOYMENT	8586	1039.2	1.0	7.6	4941	3904	3866
LESS: Main Chutes	-411	1091.5	-1.1	7.6	43	16	35
C/M AT IMPACT	8175	1036.5	1.1	7.6	4898	3632	3576

NOTE: *Centers of gravity are in the NASA reference system except that the longitudinal has an origin 998.7 inches below the tangency of the Command Module structure mold line.

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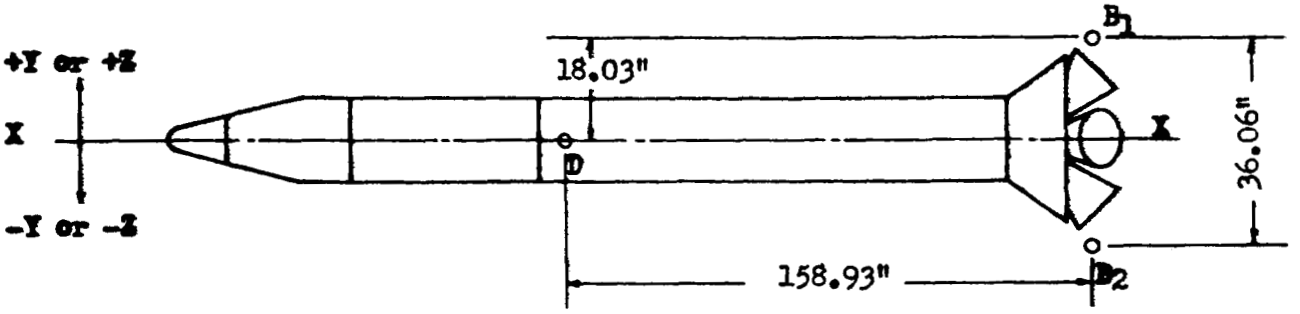
ACTUAL WEIGHT AND BALANCE DATA FORM
LAUNCH ESCAPE SYSTEM - ASSEMBLY LESS TOWER



PLAN VIEW

Vehicle No. Boilerplate No. 6 **Performed By** K. Beets

Location Downey, Calif. **Date Performed** 4 May 1963

WEIGHT DERIVATION							
REACT POINT	LOAD CELL	GROSS READING	CELL CORR	CORRECTED READING	Δ "g" CORR	CALIB CORR	WEIGHT
B_1	1	1069	+2	1071	+1	0	1072
D	2	4194	+4	4198	+3	0	4201
B_2	3	1083	+2	1085	+1	0	1086

WEIGHT AND X - Y CENTER OF GRAVITY						
DESCRIPTION	REACT POINT	WEIGHT	X STA	X MOMENT	Y STA	Y MOMENT
Cell Location	B_1	1072	1200.92	1287386	18.03	19328
Cell Location	D	4201	1359.85	5712730	0.00	0
Cell Location	B_2	1086	1200.92	1304199	-18.03	-19581
GROSS (as weighed)		6359	1305.92	8304315	- 0.04	- 253
Less: Fwd Tare		-165	1359.85	-224375	0.00	0
Aft Tare		-140	1201.60	-168224	0.00	0
NET (as weighed)		6054	1306.86	7911716	-0.04	- 253
CORRECTED WEIGHT AND CG (X-Y)		6054	1306.9	7911716	-0.04	- 253

Weight certified
WITNESSED BY: [signature]
NASA

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NR 9970-438
SID 63-143-6

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ACTUAL WEIGHT AND BALANCE DATA FORM
LAUNCH ESCAPE SYSTEM - ASSEMBLY LESS TOWER

Vehicle No. Boilerplate No. 6 Performed By K. Beets

Location Downey, Calif. Date Performed 4 May 1963

WEIGHT DERIVATION							
REACT POINT	LOAD CELL	GROSS READING	CELL CORR	CORRECTED READING	Δ "g" CORR	CALIB CORR	WEIGHT
B_1	1	1084	0	1084	+1	0	1085
D	2	4203	0	4203	+3	0	4206
B_2	3	1071	0	1071	+1	0	1072

WEIGHT AND X - Z CENTER OF GRAVITY						
DESCRIPTION	REACT POINT	WEIGHT	X STA	X MOMENT	Z STA	Z MOMENT
Cell Location	B_1	1085	1200.92	1302998	18.03	19563
Cell Location	D	4206	1359.85	5719529	0.00	0
Cell Location	B_2	1072	1200.92	1287386	-18.03	-19328
GROSS (as weighed)		6363	1305.97	8309913	0.04	235
Less: Fwd Tare		-165	1359.85	-224375	0.00	0
Aft Tare		-140	1201.60	-168224	0.00	0
NET (as weighed)		6058	1306.92	7917314	0.04	235
CORRECTED WEIGHT AND CG (X-Z)		6058	1306.9	7917314	0.04	235

WEIGHT AND CENTER OF GRAVITY SUMMARY ASSEMBLY LESS TOWER						
CORRECTED WEIGHT *	CENTER OF GRAVITY					
	X_a*	X MOMENT	Y_a	Y MOMENT	Z_a	Z MOMENT
6056	1306.9	7914586	-0.04	- 253	0.04	235

* Average from sheets 1 and 2

Weight certified WITNESSED BY: [signature] NASA

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MX 9970-438-1
SID 63-143-6

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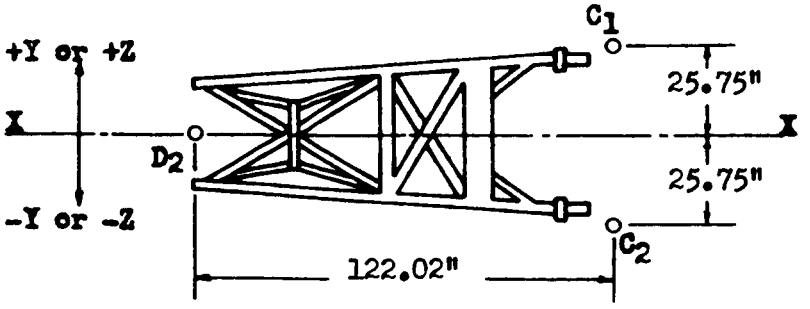
ACTUAL WEIGHT AND BALANCE DATA FORM
LAUNCH ESCAPE SYSTEM - TOWER ASSEMBLY



PLAN VIEW

Vehicle No. Boilerplate No. 6 **Performed By** J. Hedger

Location Downey, Calif. **Date Performed** 4 May 1963

WEIGHT DERIVATION							
REACT POINT	LOAD CELL	GROSS READING	CELL CORR	CORRECTED READING	Δ "g" CORR	CALIB CORR	WEIGHT
D_2	1	149	+6	155	0	0	155
C_1	2	252	+5	257	0	0	257
C_2	3	250	+6	256	0	0	256

WEIGHT AND X - Y CENTER OF GRAVITY						
DESCRIPTION	REACT POINT	WEIGHT	X STA	X MOMENT	Y STA	Y MOMENT
Cell Location	D_2	155	1205.34	186828	0.00	0
Cell Location	C_1	257	1083.32	278413	25.75	6618
Cell Location	C_2	256	1083.32	277330	-25.75	-6592
GROSS (as weighed)		668	1111.63	742571	0.04	26
Less: Fwd Tare		-10	1205.34	- 12053	0.00	0
Aft Tare		-318	1083.29	-344486	0.39	- 124
NET (as weighed)		340	1135.39	386032	- 0.29	- 98
CORRECTED WEIGHT AND CG (X-Y)		340	1135.4	386032	- 0.29	- 98

Weight Certified ~~WITNESSED~~ BY: [signature]
NASA

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MX 9970-439
SID 63-143-6

ACTUAL WEIGHT AND BALANCE DATA FORM
LAUNCH ESCAPE SYSTEM - TOWER ASSEMBLY

Vehicle No. Boilerplate No. 6 Performed By J. Hedger

Location Downey, California Date Performed 4 May 1963

WEIGHT DERIVATION							
REACT POINT	LOAD CELL	GROSS READING	CELL CORR	CORRECTED READING	Δ "g" CORR	CALIB CORR	WEIGHT
D_2	1	145	+12	157	0	0	157
C_1	2	230	+11	241	0	0	241
C_2	3	259	+12	271	0	0	271

WEIGHT AND X - Z CENTER OF GRAVITY						
DESCRIPTION	REACT POINT	WEIGHT	X STA	X MOMENT	Z STA	Z MOMENT
Cell Location	D_2	157	1205.34	189238	0.00	0
Cell Location	C_1	241	1083.32	261080	25.75	6206
Cell Location	C_2	271	1083.32	293580	-25.75	-6978
GROSS (as weighed)		669	1111.96	743898	- 1.15	- 772
Less: Fwd Tare		- 10	1205.34	- 12053	0.00	0
Aft Tare		- 318	1083.29	-344486	- 0.43	137
NET (as weighed)		341	1135.95	387359	- 1.86	- 635
CORRECTED WEIGHT AND CG (X-Z)		341	1136.0	387359	- 1.86	- 635

WEIGHT AND CENTER OF GRAVITY SUMMARY TOWER ASSEMBLY						
CORRECTED WEIGHT*	CENTER OF GRAVITY					
	X_a*	X MOMENT	Y_a	Y MOMENT	Z_a	Z MOMENT
341	1135.7	387274	- 0.29	- 98	- 1.86	- 635

* Average from sheets 1 and 2

CERTIFIED WITNESSED BY: NASA

MX 9970-439-1
SID 63-143-6

ACTUAL WEIGHT AND CENTER OF GRAVITY SUMMARY

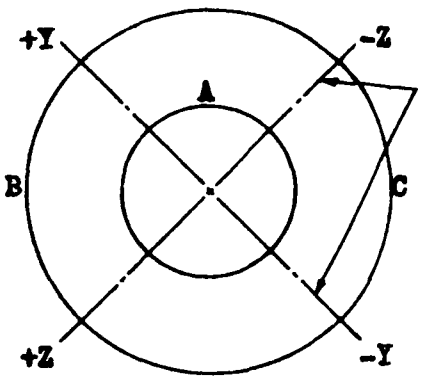
BOILERPLATE NO. 6

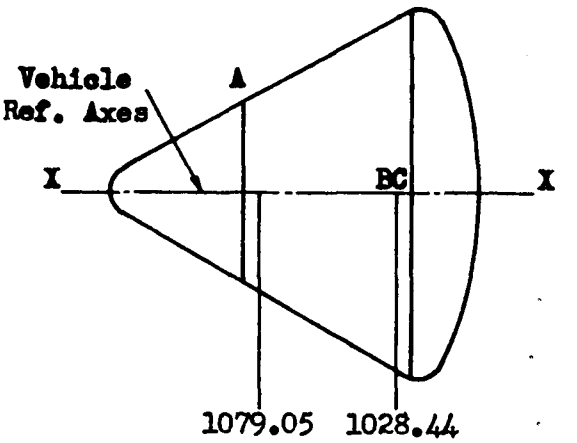
LAUNCH ESCAPE SYSTEM

DESCRIPTION	WEIGHT	CENTER OF GRAVITY *					
		X	X MOMENT	Y	Y MOMENT	Z	Z MOMENT
L.E.S. Less Tower	6056	1306.9	7914586	- 0.04	- 253	0.04	235
L.E.S. Tower	341	1135.7	387274	- 0.29	- 98	-1.86	-635
Total - Corrections (Page 14)	33	1126.9	37188	16.2	535	12.8	422
TOTAL LAUNCH ESCAPE SYSTEM	6430	1296.9	8339048	0.03	184	0.00	22

NOTE: *Centers of gravity are in the NASA reference system except that the longitudinal has an origin 998.7 inches below the tangency of the Command Module structure mold line.

ACTUAL WEIGHT AND BALANCE DATA FORM
COMMAND MODULE
HORIZONTAL





Vehicle No. Boilerplate No. 6 **Performed By** J. Hedger

Location Downey, California **Date Performed** 3 May 1963

WEIGHT DERIVATION							
REACT POINT	LOAD CELL	GROSS READING	CELL CORR	CORRECTED READING	Δ "g" CORR	CALIB CORR	WEIGHT
C	1	3062	0	3062	+2	0	3064
A	2	2960	0	2960	+2	0	2962
B	3	3509	0	3509	+3	0	3512

WEIGHT AND X CENTER OF GRAVITY				
DESCRIPTION	REACT POINT	WEIGHT	X STA	X MOMENT
Cell Location	C	3064	1028.44	3151140
Cell Location	A	2962	1079.05	3196146
Cell Location	B	3512	1028.44	3611881
GROSS (as weighed)		9538	1044.2	9959167
Less: Sling and Trunnions		- 292	1079.05	- 315083
Fwd Jack Pad		- 6	1028.44	- 6171
Aft Jack Pads		- 37	1028.44	- 38052
NET (as weighed)		9203	1043.1	9599861
Less Total Corrections(page 15)		- 195	1094.9	- 213506
CORRECTED WEIGHT AND CG (X)		9008	1042.0	9386355

Weight Certified WITNESSED BY: [signature]
NASA

CONFIDENTIAL

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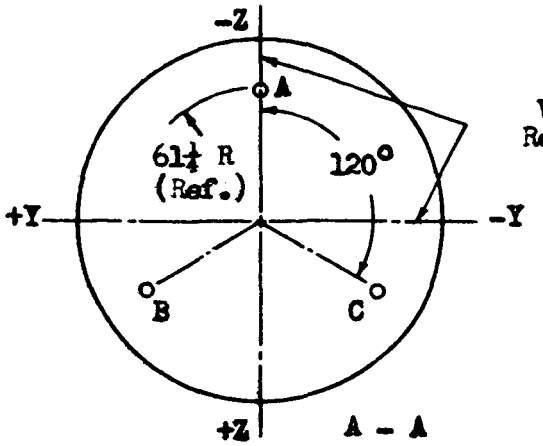
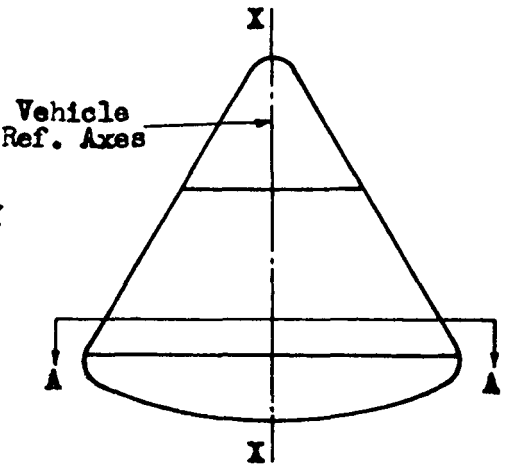
ACTUAL WEIGHT AND BALANCE DATA FORM
COMMAND MODULE
VERTICAL





Vehicle No. Boilerplate No. 6 **Performed By** K. Beets

Location Downey, Calif. **Date Performed** 6 May 1963

WEIGHT DERIVATION							
REACT POINT	LOAD CELL	GROSS READING	CELL CORR	CORRECTED READING	Δ "g" CORR	CALIB CORR	WEIGHT
C	1	3583	0	3583	+3	0	3586
B	2	3630	+1	3631	+3	0	3634
A	3	2454	0	2454	+2	0	2456

WEIGHT AND Y - Z CENTER OF GRAVITY						
DESCRIPTION	REACT POINT	WEIGHT	Y STA	Y MOMENT	Z STA	Z MOMENT
Cell Location	C	3586	-53.00	- 190058	30.64	109875
Cell Location	B	3634	52.98	192529	30.64	111346
Cell Location	A	2456	0.0	0	-61.25	-150430
GROSS (as Weighed)		9676	0.26	2471	7.32	70791
Less Weighing Fixture (Ring)		- 474	- 0.23	109	0.01	- 5
NET (as Weighed)		9202	0.28	2580	7.69	70786
Less Total Correction (Page 15)		- 195	-31.4	6123	25.4	- 4953
CORRECTED WEIGHT AND CG (Y-Z)		9007	0.97	8703	7.31	65833

Weight Certified ~~WITNESSED~~ BY: [redacted]
NASA

[redacted]

ACTUAL WEIGHT AND CENTER OF GRAVITY SUMMARY

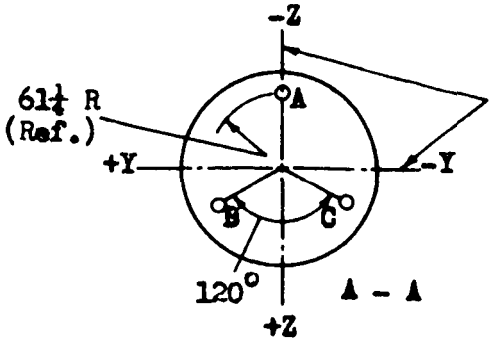
BOILERPLATE NO. 6

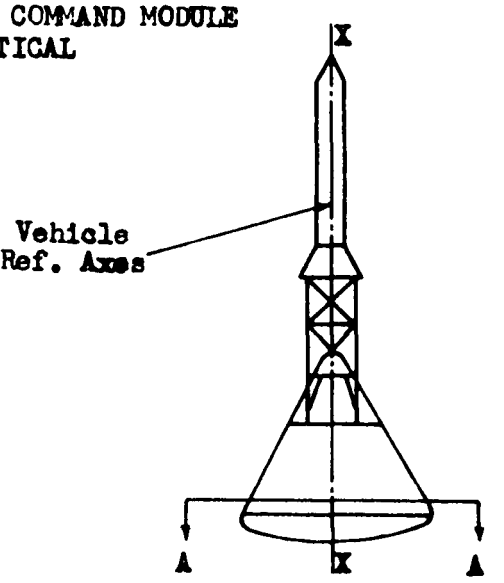
COMMAND MODULE

DESCRIPTION	WEIGHT	CENTER OF GRAVITY *					
		X	X MOMENT	Y	Y MOMENT	Z	Z MOMENT
COMMAND MODULE	9008	1042.0	9386336	0.97	8703	7.31	65833

NOTE: *Centers of gravity are in the NASA reference system except that the longitudinal has an origin 998.7 inches below the tangency of the Command Module structure mold line.

ACTUAL WEIGHT AND BALANCE DATA FORM
LAUNCH ESCAPE SYSTEM AND COMMAND MODULE
COMBINED - VERTICAL





Vehicle No. Boilerplate No. 6 Performed By J. Hedger

Location Downey, Calif. Date Performed 7 May 1963

WEIGHT DERIVATION							
REACT POINT	LOAD CELL	GROSS READING	CELL CORR	CORRECTED READING	Δ "g" CORR	CALIB CORR	WEIGHT
C	1	5783	0	5783	+4	0	5787
B	2	5733	0	5733	+4	0	5737
A	3	4595	0	4595	+4	0	4599

WEIGHT AND Y - Z CENTER OF GRAVITY						
DESCRIPTION	REACT POINT	WEIGHT	Y STA	Y MOMENT	Z STA	Z MOMENT
Cell Location	C	5787	-53.00	- 306711	30.64	177314
Cell Location	B	5737	52.98	303946	30.64	175782
Cell Location	A	4599	0.00	0	-61.25	-281689
GROSS (as weighed)		16123	- 0.17	- 2765	4.43	71407
Less Weighing Fixture (Ring)		- 474	- 0.23	109	0.01	- 5
Less Projector, Mount and Target		- 51	0.00	0	0.50	- 25
NET (as weighed)		15598	- 0.17	- 2656	3.58	71377
Less Total Corrections (Page 14)		- 195	-31.4	6123	25.4	- 4953
Plus Total Corrections (Page 15)		33	16.2	535	12.8	422
CORRECTED WEIGHT AND CG (Y-Z)		15436	0.26	4002	4.33	66846

Weight Certified
~~WITNESSED~~ BY: NASA

Final Weighing

MX 9970-435
SID 63-143-6

CORRECTIONS TO ACTUAL WEIGHT AND BALANCE

BOILERPLATE NO. 6

LAUNCH ESCAPE SYSTEM

CORRECTIONS		WEIGHT	CENTER OF GRAVITY *		
			X	Y	Z
LESS:	Cover, Accel.	- 0.92	1147.8	25.3	22.4
	Fitting	- 3.71	1219.2	0.0	0.0
PLUS:	Door	0.40	1088.0	25.1	0.0
	Spacers	1.20	1203.5	18.7	12.1
	Cover	1.40	1147.8	25.3	22.4
	Fitting	1.00	1110.4	- 5.3	16.4
	Instr. Instl.	18.54	1161.0	20.8	14.4
	Channel	0.31	1458.2	0.0	0.0
	Plate	6.12	1114.6	19.0	19.0
	Explosive Bolt Instl.	9.00	1084.0	0.0	0.0
TOTAL CORRECTIONS		33.34	1126.9	16.2	12.8

NOTE: *Centers of gravity are in the NASA reference system except that the longitudinal has an origin 998.7 inches below the tangency of the Command Module structure mold line.

CORRECTIONS TO ACTUAL WEIGHT AND BALANCE

BOILERPLATE NO. 6

COMMAND MODULE

CORRECTIONS		WEIGHT	CENTER OF GRAVITY *		
			X	Y	Z
LESS:	Ballast	- 257.8	1054.5	-21.8	21.5
	Ballast	- 257.8	1048.4	51.4	7.2
	Change Rate Gyro	- 2.8	1076.1	- 1.4	19.9
	Signal Cond. Box	- 66.0	1046.5	0.0	38.0
	Chute tie down Rings	- 2.0	1083.0	- 5.0	7.5
PLUS:	Coax Channel and Brackets	2.0	1022.4	43.4	-14.6
	Signal Cond. Support	3.0	1046.1	- 0.8	43.4
	External Glass and Brackets	1.5	1059.0	-45.6	-25.8
	External Glass and Brackets	1.5	1076.4	0.0	-41.4
	External Glass and Brackets	1.5	1063.3	30.3	-39.4
	External Glass and Brackets	1.5	1067.1	42.7	-20.4
	Fwd. Bulkhead Brackets	1.2	1087.8	11.8	18.0
	Fairings (Hatch)	2.0	1068.7	0.0	-43.4
	Fairings (Hot Tube)	1.4	1084.5	0.0	0.0
	Paint (Additional)	4.0	1066.2	0.0	0.0
	Ballast	257.8	1023.6	52.2	4.0
	Signal Cond. Box	66.0	1047.4	0.0	34.8
	Chute tie down Rings	2.0	1083.0	- 4.5	5.5
	Battery	30.0	1020.0	9.6	41.0
	Battery	16.0	1018.0	- 9.0	38.0
TOTAL CORRECTIONS		- 195.0	1094.9	-31.4	25.4

NOTE: *Centers of gravity are in the NASA reference system except that the longitudinal has an origin 998.7 inches below the tangency of the Command Module structure Mold line.